IN THE CLAIMS:

Claim Summary

New claims 35-97 are added. For the Examiner's convenience, and in accordance with the revised amendment format permitted by the Patent Office, a complete listing of the claims is set forth below with corresponding status identifiers for each claim.

Amended Claims

1. (Original) An energy absorbing system comprising:

a fitting having a crack inducing surface extending radially outward in relation to an axis;

an energy absorbing element formed by a hollow body, said hollow body extending along said axis and having a first end adapted to interact with said crack inducing surface of said fitting so as to radially spread said hollow body thereby forming cracks in said hollow body in response to forces applied in a direction substantially parallel to said axis which forces push said crack inducing surface against said first end;

said hollow body having layers of reinforcing flat material embedded in a matrix material and comprising a single winding of said flat material about said axis;

a number of layers of said reinforcing flat material in said hollow body being different in different areas of said hollow body;

said layers of reinforcing flat material extending in said hollow body in a defined manner to cause: (i) said forces to be absorbed by said hollow body without folding; and (ii) the layers of reinforcing flat material to receive cracks which begin at said first end and expand through said different areas of said hollow body in said direction substantially parallel to said axis.

2. (Original) An energy absorbing system in accordance with claim 1, further comprising a crack triggering element arranged on one of said fitting or said hollow body end.

3. (Original) An energy absorbing system in accordance with claim 2, wherein said crack triggering element comprises a chamfer at said first end of said hollow body adapted to interact with said crack inducing surface.

4. (Original) An energy absorbing system in accordance with claim 2, wherein said crack triggering element comprises slits in said first end of said hollow body.

5. (Original) An energy absorbing system in accordance with claim 1, wherein said reinforcing flat material comprises a single piece of flat material.

6. (Original) An energy absorbing system in accordance with claim 5, wherein the single piece of flat material has a section with a maximum width in a direction parallel to said axis and at least one section with a lesser width in said direction parallel to said axis.

7. (Original) An energy absorbing system in accordance with claim 1, wherein sections of the flat material are contoured to provide the different areas having the different number of layers during supplying the flat material to a mandrel to form said hollow body.

8. (Original) An energy absorbing system in accordance with claim 7, wherein the piece of flat material is contoured by means of a cutting procedure.

9. (Original) An energy absorbing system in accordance with claim 1, wherein sections of the piece of flat material are contoured to provide the different areas having the different number of layers prior to supplying the flat material to a mandrel to form said hollow body.

10. (Original) An energy absorbing system in accordance with claim 9, wherein the piece of flat material is contoured by means of a cutting procedure.

11. (Original) An energy absorbing system in accordance with claim 1, wherein a maximum extension of a contoured piece of flat material in a direction parallel to said axis corresponds to a maximum extension of the hollow body in said direction parallel to said axis.

12. (Original) An energy absorbing system in accordance with claim 1, wherein multiple pieces of flat material are supplied to a winding procedure in parallel to form said hollow body.

13. (Original) An energy absorbing system in accordance with claim 12, wherein the multiple pieces of flat material

are supplied to the winding procedure as a connected arrangement of pieces of flat material in which said pieces of flat material are arranged in a sequence extending in a direction parallel to said axis.

14. (Original) An energy absorbing system in accordance with claim 13, wherein the multiple pieces of flat material are connected in a section which increases the number of layers in all the areas of the hollow body in an equal manner.

15. (Original) An energy absorbing system in accordance with claim 13, wherein the pieces of flat material are connected in a section with maximum width.

16. (Original) An energy absorbing system in accordance with claim 1, wherein the reinforcing flat material is impregnated with the matrix material prior to a winding of the reinforcing flat material to form the hollow body.

17. (Original) An energy absorbing system in accordance with claim 16, wherein the winding of the reinforcing flat material is carried out with one of a liquid or a liquifiable matrix material.

18. (Original) An energy absorbing system in accordance with claim 17, wherein the matrix material is liquefied during the winding.

19. (Original) An energy absorbing system in accordance with claim 18, wherein the matrix material is kept at a melting temperature during the entire winding of the reinforcing flat material.

20. (Original) An energy absorbing system in accordance with claim 19, wherein the matrix material is heated to the melting temperature during the winding of the reinforcing flat material.

21. (Original) An energy absorbing system in accordance with claim 20, wherein the matrix material is heated to the melting temperature by means of a mandrel which is heated and kept at the melting temperature.

22. (Original) An energy absorbing system in accordance with claim 19, wherein the matrix material is heated to the melting temperature by means of a mandrel which is heated and kept at the melting temperature.

23. (Original) An energy absorbing system in accordance with claim 22, wherein the mandrel is heated to the melting temperature of the matrix material prior to the winding.

24. (Original) An energy absorbing system in accordance with claim 23, wherein the mandrel is heated to the melting

temperature of the matrix material prior to insertion into a winding device.

25. (Original) An energy absorbing system in accordance with claim 16, wherein the matrix material is heated to such an extent that it is adequately liquefied during the winding of the reinforcing flat material.

26. (Original) An energy absorbing system in accordance with claim 25, wherein the matrix material is hardened in the hollow body following the winding.

27. (Original) An energy absorbing system in accordance with claim 26, wherein the matrix material is hardened with the hollow body seated on a winding tube.

28. (Original) An energy absorbing system in accordance with claim 1, wherein the matrix material comprises one of a thermoplastic material or a duroplast material.

29. (Original) An energy absorbing system in accordance with claim 1, wherein the surface of said fitting is toroidal in shape.

30. (Original) An energy absorbing system in accordance with claim 1, wherein the fitting comprises:

a cylindrical guide section having a casing surface which abuts an inner surface of said hollow body at said first hollow body end; and

a channel section extending annularly around the axis and having a base surface bordering the casing surface and extending radially outward in relation to said axis.

31. (Original) An energy absorbing system in accordance with claim 30, wherein said channel section is toroidal in shape.

32. (Original) An energy absorbing system in accordance with claim 1, further comprising:

a second fitting having a contact surface transverse to said axis and adapted to support the hollow body at a second end thereof.

33. (Original) An energy absorbing system in accordance with claim 32, further comprising:

securing means for securing the second end of the hollow body to said second fitting.

34. (Original) An energy absorbing system in accordance with claim 33, wherein said second end of said hollow body is adapted to absorb said forces without folding and to transfer these forces to said second fitting so that the cracks are induced in said first end of said hollow body and extend along said axis toward said second end.

35. (New) A process for the production of an energy absorbing structural element, comprising:

supplying a single piece of flat material to a mandrel, said flat material having reinforcing fibers embedded in a matrix;

winding said single piece of flat material on said mandrel in a single winding procedure to form a hollow body extending along an axis;

adapting a first end of said hollow body to interact with a fitting having a surface extending radially outward in relation to said axis so as to radially spread said first end of the hollow body in response to forces applied in the direction parallel to said axis on at least one of said first end and a second end of said hollow body which push said first end against said fitting;

said flat material configured to have at least some of said reinforcing fibers oriented in an azimuthal direction in relation to said axis when said flat material is wound to form said hollow body and to produce a layered structure having a different number of layers of the flat material in different areas of said hollow body;

said layered structure of said hollow body causing said forces to be absorbed by said hollow body without folding in such a manner that said forces generate cracks in said layered structure at said first end of said hollow body which cracks extend in said direction parallel to said

axis and which propagate from said first end toward said second end.

36. (New) A process as defined in claim 35, wherein the single piece of flat material has a section with a maximum width in said direction parallel to said axis and at least one section with a lesser width in said direction parallel to said axis.

37. (New) A process as defined in claim 35, wherein the flat material is contoured in a section influencing the different areas having the different number of layers during the course of supplying the flat material to the mandrel.

38. (New) A process as defined in claim 35, wherein the piece of flat material is contoured in the section influencing the different areas having the different number of layers prior to supplying the flat material to the mandrel.

39. (New) A process as defined in claim 38, wherein the piece of flat material is contoured by means of a cutting procedure.

40. (New) A process as defined in claim 37, wherein the piece of flat material is contoured by means of a cutting procedure.

41. (New) A process as defined in claim 35, wherein a maximum extension of a contoured piece of flat material in said direction parallel to said axis corresponds to a maximum extension of the hollow body in said direction parallel to said axis.

42. (New) A process as defined in claim 35, wherein multiple pieces of flat material are supplied to the winding procedure in parallel.

43. (New) A process as defined in claim 42, wherein the multiple pieces of flat material are supplied to the winding procedure as a connected arrangement of pieces of flat material in which said pieces of flat material are arranged in a sequence extending in said direction parallel to said axis.

44. (New) A process as defined in claim 43, wherein the multiple pieces of flat material are connected in a section which increases the number of layers in all the areas of the hollow body in an equal manner.

45. (New) A process as defined in claim 43, wherein the pieces of flat material are connected in a section with maximum width.

46. (New) A process as defined in claim 35, wherein the flat material is impregnated with the matrix material prior to the winding of the flat material to form the hollow body.

47. (New) A process as defined in claim 46, wherein the winding of the flat material is carried out with one of a liquid or a liquifiable matrix material.

48. (New) A process as defined in claim 47, wherein the matrix material is liquefied during the winding.

49. (New) A process as defined in claim 48, wherein the matrix material is kept at the melting temperature during the entire winding of the flat material.

50. (New) A process as defined in claim 49, wherein the matrix material is heated to the melting temperature during the winding of the flat material.

51. (New) A process as defined in claim 49, wherein the matrix material is heated to the melting temperature by means of the mandrel which is heated and kept at the melting temperature.

52. (New) A process as defined in claim 48, wherein the matrix material is heated to the melting temperature by

means of the mandrel which is heated and kept at the melting temperature.

53. (New) A process as defined in claim 52, wherein the mandrel is heated to the melting temperature of the matrix material prior to the winding.

54. (New) A process as defined in claim 53, wherein the mandrel is heated to the melting temperature of the matrix material prior to insertion into a winding device.

55. (New) A process as defined in claim 35, wherein the matrix material is heated to such an extent that it is adequately liquefied during the winding of the flat material.

56. (New) A process as defined in claim 55, wherein the matrix material is hardened in the hollow body following the winding.

57. (New) A process as defined in claim 56, wherein the matrix material is hardened with the hollow body seated on a winding tube.

58. (New) A process as defined in claim 56, wherein one or more mandrels are each wound with a hollow body and are combined during the hardening of the matrix material to

form groups of mandrels passing together through the hardening phase.

59. (New) A process as defined in claim 58, wherein the hollow bodies are cooled when seated on the mandrels.

60. (New) A process as defined in claim 59, wherein the hollow bodies are withdrawn from the mandrels.

61. (New) A process as defined in claim 60, wherein the hollow bodies, which are connected, are separated prior to the withdrawal from the mandrels.

62. (New) A process as defined in claim 59, wherein the hollow bodies, which are connected, are separated following the withdrawal from the mandrels.

63. (New) A process in accordance with claim 35, wherein said hollow body end comprises one of a chamfered end or triggering slits.

64. (New) A process in accordance with claim 35, wherein the surface of said fitting is toroidal in shape.

65. (New) A process in accordance with claim 35, wherein said number of layers of said flat material progressively vary from one end of said hollow body to the other end of said hollow body.

66. (New) A process for the production of an energy absorbing structural element, comprising:

supplying multiple pieces of flat material having at least reinforcing fibers embedded in a matrix material to a mandrel;

winding said multiple pieces of flat material on said mandrel in a single winding procedure to form a hollow body extending along an axis; and

adapting a first end of said hollow body to interact with a fitting having a surface extending radially outward in relation to said axis so as to radially spread said first end of the hollow body in response to forces applied in the direction parallel to said axis on at least one of said first end and a second end of said hollow body which push said first end against said fitting;

said pieces of flat material configured to have at least some of said reinforcing fibers oriented in an azimuthal direction in relation to said axis when said pieces of flat material are wound to form said hollow body and to produce a layered structure having a different number of layers of the flat material in different areas of said hollow body;

said layered structure of said hollow body causing said forces to be absorbed by said hollow body without folding in such a manner that said forces generate cracks in said layered structure at said first end of said hollow body which cracks extend in said direction parallel to said

axis and which propagate from said first end toward said second end.

67. (New) A process as defined in claim 66, wherein at least one of the pieces of flat material has a section with a maximum width in said direction parallel to said axis and at least one section with a lesser width in said direction parallel to said axis.

68. (New) A process as defined in claim 66, wherein the pieces of flat material are contoured in a section influencing the different areas having the different number of layers during the course of supplying the flat material to the mandrel.

69. (New) A process as defined in claim 66, wherein the pieces of flat material are contoured in the section influencing the different areas having the different number of layers prior to supplying the flat material to the mandrel.

70. (New) A process as defined in claim 66, wherein the pieces of flat material are contoured by means of a cutting procedure.

71. (New) A process as defined in claim 66, wherein a maximum extension of a contoured piece of flat material in said direction parallel to said axis corresponds to a

maximum extension of the hollow body in the direction parallel to said axis.

72. (New) A process as defined in claim 66, wherein the multiple pieces of flat material are supplied to the winding procedure in parallel.

73. (New) A process as defined in claim 72, wherein the multiple pieces of flat material are supplied to the winding procedure as a connected arrangement of pieces of flat material in which said pieces of flat material are arranged in a sequence extending in said direction parallel to said axis.

74. (New) A process as defined in claim 73, wherein the multiple pieces of flat material are connected in a section which increases the number of layers in all the areas of the hollow body in an equal manner.

75. (New) A process as defined in claim 73, wherein the multiple pieces of flat material are connected in a section with maximum width.

76. (New) A process as defined in claim 66, wherein the matrix material is hardened in the hollow body following the winding.

77. (New) A process in accordance with claim 66, wherein said hollow body end comprises one of a chamfered end or triggering slits.

78. (New) A process in accordance with claim 66, wherein the surface of said fitting is toroidal in shape.

79. (New) A process for absorbing energy in a structural element, comprising:

providing a hollow body extending along an axis, said hollow body comprising:

a single piece of flat material having reinforcing fibers embedded in a matrix material wound on a mandrel in a single winding procedure to form a hollow body extending along an axis;

said flat material configured to have at least some of said reinforcing fibers oriented in an azimuthal direction in relation to said axis when said flat material is wound to form said hollow body and to produce a layered structure having a different number of layers of the flat material in different areas of said hollow body;

providing a fitting for interaction with a first end of said hollow body, said fitting having a surface extending radially outward in relation to said axis;

absorbing forces applied on at least one of said first end and a second end of said hollow body in the direction parallel to said axis, which forces push said first end

against said fitting, said forces being absorbed by radially spreading of said first end of the hollow body in response to said forces, said radial spreading generating cracks at said first end of said hollow body, which cracks extend in said direction parallel to said axis and which propagate through the layered structure of the hollow body from said first end toward said second end;

said layered structure of said hollow body causing said forces to be absorbed by said hollow body without folding.

80. (New) A process in accordance with claim 79, wherein said number of layers of said flat material progressively vary from one end of said hollow body to the other end of said hollow body.

81. (New) A process as defined in claim 79, wherein the single piece of flat material has a section with a maximum width in said direction parallel to said axis and at least one section with a lesser width in said direction parallel to said axis.

82. (New) A process as defined in claim 79, wherein the flat material is contoured in a section influencing the different areas having the different number of layers during the course of supplying the flat material to the mandrel.

83. (New) A process as defined in claim 79, wherein the flat material is contoured in the section influencing the different areas having the different number of layers prior to supplying the flat material to the mandrel.

84. (New) A process as defined in claim 79, wherein the piece of flat material is contoured by means of a cutting procedure.

85. (New) A process as defined in claim 79, wherein a maximum extension of a contoured piece of flat material in said direction parallel to said axis corresponds to a maximum extension of the hollow body in the direction parallel to said axis.

86. (New) A process as defined in claim 79, wherein multiple pieces of flat material are supplied to the winding procedure in parallel.

87. (New) A process as defined in claim 86, wherein the multiple pieces of flat material are supplied to the winding procedure as a connected arrangement of pieces of flat material in which said pieces of flat material are arranged in a sequence extending in said direction parallel to said axis.

88. (New) A process as defined in claim 87, wherein the multiple pieces of flat material are connected in a section

which increases the number of layers in all the areas of the hollow body in an equal manner.

89. (New) A process as defined in claim 87, wherein the multiple pieces of flat material are connected in a section with maximum width.

90. (New) A process as defined in claim 79, wherein the matrix material is hardened in the hollow body following the winding.

91. (New) A process in accordance with claim 79, wherein said hollow body end comprises one of a chamfered end or triggering slits.

92. (New) A process in accordance with claim 79, wherein the surface of said fitting is toroidal in shape.

93. (New) A process for the production of a plurality of energy absorbing structural elements, comprising:

supplying multiple pieces of flat material having reinforcing fibers embedded in a matrix material to a mandrel, said mandrel having an axis of rotation;

said multiple pieces of flat material being an arrangement of a sequence of single pieces of flat material connected to each other;

said sequence of single pieces of flat material extending parallel to said axis of rotation of said mandrel;

winding said sequence of single pieces of flat material on said mandrel in a single winding procedure to form a plurality of hollow bodies extending along said axis of rotation of said mandrel, each of said hollow bodies being produced by winding one of said single pieces of flat material;

each single piece of flat material being contoured in such a manner that said single winding procedure produces a different number of layers of the flat material in different areas of each of said hollow bodies and that said different number of layers of said flat material in each of said hollow bodies provides a characteristic absorption of energy if forces applied in a direction parallel to said axis on at least one of a first and second end of said hollow body are absorbed by said hollow body with the generation of cracks extending through said different areas of said hollow body.

94. (New) A process as defined in claim 93, wherein the multiple pieces of flat material are connected in a section of said single pieces of flat material which increases the number of layers in all the areas of the hollow body in an equal manner.

95. (New) A process as defined in claim 93, wherein the multiple pieces of flat material are connected in a section of said single pieces of flat material with maximum width.

96. (New) A process as defined in claim 93, wherein a first sequence of single pieces of flat material is used in one production step for a first plurality of energy absorbing structural elements and a second sequence of single pieces of flat material is used in the next production step for a second plurality of energy absorbing structural elements, said second sequence of single pieces of flat material having a shape which is complementary to the shape of the first sequence of single pieces of flat material.

97. (New) A process as defined in claims 93, wherein said hollow bodies in said plurality of hollow bodies are connected to each other and are separated from each other in a cutting step.